An assessment tool and integrated index for sustainable oil palm production

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Abstract

Many prominent sectors of the international agricultural commodities market have been calling upon their stakeholders to define and implement social responsibility and sustainability benchmarks, aiming at product quality and production practices certification. One of these initiatives, the Roundtable for Sustainable Palm Oil (RSPO), is compelling all producing parties (plantations as well as smallholders) to comply with proposed Principles, Criteria and Indicators (PC&I), in an international social responsibility assurance movement. In addition to these PC&I, an integrated sustainability assessment procedure is being sought out in a Cirad / Embrapa / Partners coordinated effort, as a complementary method for the environmental management of oil palm plantations. The aim is to assure both procedural social responsibility (PC&I compliance) and actual environmental and biodiversity conservation in the field. The proposed action to fulfill this objective has been the adaptation of a 'System for Weighted Environmental Impact Assessment in Oil Palm Production' (APOIA-OilPalm). The present document reports on the conceptual basis, the methodological adaptation and the validation field trials carried out for consolidation of the proposed APOIA-OilPalm sustainability index. The experience attained in the development and international negotiation of this proposed sustainability index, dedicated to such an important productive sector such as that of palm oil, can be instrumental for other environmental management and eco-certification initiatives, such as the Roundtables on Responsible Soy, Sustainable Biofuels, and Sustainable Forests; the Better Sugarcane Initiative, among others.

Introduction

Oil palm is one of the most important crops in Asia and Africa and is being extended also in South America, due to several valuable attributes: i) high productivity and adaptability to tropical conditions; ii) important generation of work opportunities in a year-round cycle; iii) flexibility of management, from intensive mono-stands to diversified agroforestry; and iv) a currently rewarding return to investment, due mainly to the strong growth of world demand for palm oil (Sheil et al., 2009). However, inexorable negative consequences of the expansion of large scale plantations in many regions have been observed, such as conflicts with local communities and indigenous populations (Colchester et al., 2006), or the impacts on biodiversity in South East Asia (Fitzherbert et al., 2008; Koh and Wilcove, 2008).

Pressured by public opinion and aware of the need for promoting a socio-environmentally sound business, the palm oil industry embarked on a project with the World Wildlife Fund and other interest groups and stakeholders, in a quest to develop and propose sustainability guidelines for the sector. A cooperation was hence established with Aarhus United UK Ltd, Golden Hope Plantations Berhad, Migros, Malaysian Palm Oil Association, Sainsbury's and Unilever, with the objective of joining growers, processors and traders, goods manufacturers, retailers, NGOs, Bank/Investors and consumers to amalgamate their points of view in a "Code of Conduct" toward a 'responsible palm oil production chain' (Omont, 2005).

To kick-start the movement, a stakeholder's meeting was prepared in Kuala Lumpur (Malaysia) in August 2003 with the participation of 200 members from 16 countries. Initially bound by a Statement of Intent (SoI), the stakeholders signed a formal contract under Article 60 of the Swiss Civil Code on 8 April 2004, creating the 'Roundtable on Sustainable Palm Oil' (RSPO). A major development happened in October 2004 in the RT-2 meeting of RSPO held in Jakarta, with the implementation of Principles, Criteria and Indicators (PC&I) for sustainable palm oil.

With a broad vision and an evolving effort to include farmers all over the world, the PC&I approach is a procedure that aligns terms of reference and a practical Code of Conduct regarding socio-environmental responsibility objectives. Its main characteristics can be found in wood certification experiences promoted by the Forest Stewardship Council (FSC, 2000) and in a documentation of the Centre for International Forestry (CIFOR, 1999).

Along this process for the establishment, agreement and conformity check on the "terms of reference" for common institutional practices regarding the PC&I for socio-environmental responsibility in the palm oil sector, the opportunity and necessity for continuous improvement call for new actions, to forward the sustainable development momentum. In this sense, a step ahead is been developed to introduce agro-ecological and socio-environmental indicators directed toward integrated sustainability assessment, ensuing technical performance advice, and environmental management practices for oil palm production (Rodrigues et al, 2007a).

The objective has been to organize a systemic set of indicators in an integrated sustainability index that combine the compliance with previously defined PC&I in a comprehensive and meaningful quantitative measurement, offering an easily applicable assessment system for producers (Rodrigues et al., 2007b; 2009a). An environmental management tool is now being proposed, for (i) preparing farmers / plantations for certification, (ii) checking the impacts effected by PC&I adequacy at the field level (that is, to document improvements), and for (iii) environmental management decision making on how to promote continuous improvement (RSPO's Principle 8) in environmental management.

The present document reports on the conceptual basis, the methodological adaptation and the validation field trials carried out for consolidation of the proposed set of indicators and the integrated 'APOIA-OilPalm' sustainability index.

Methodological development: the APOIA-OilPalm sustainability assessment system

Based on a proposed 'System for Weighted Environmental Impact Assessment of Rural Activities' (Rodrigues and Campanhola, 2003), the APOIA-OilPalm sustainability assessment system consists of 64 integrated indicators, formulated toward objective and quantitative evaluation focused on five sustainability dimensions: i) Landscape ecology, ii) Environmental quality (atmosphere, water and soils), iii) Economic Values, iv) Sociocultural values, and v) Management and Administration.

The APOIA-OilPalm indicators and composite indices are constructed as multiattribute-utility scaling checklists (Bisset, 1987), integrated as to systemically encompass the rural establishment, the local environmental compartments, the productive processes and the farm's interface with local market settings (Rodrigues et al, 2009b). Indicators were selected, constructed and organized as to include the range of possible socio-environmental impacts, with careful consideration to avoid gaps as well as double counting of variables concerning the 'triple-bottom-line of sustainability' (environmental, social and economic criteria). The complete set of APOIA-OilPalm indicators and their respective measurement units sought out in field sampling and laboratory analyses are listed in Table 1[1].

[1] For access to the operational spreadsheets of the APOIA-OilPalm system, please contact the authors.

Table 1. Dimensions and indicators integrated in the APOIA-OilPalm system and specific measurement units for field- and laboratory-obtained data.

Dimensions and indicators	Measurement units for field and laboratory data
Landscape ecology dimension	
1. Natural habitats physiognomy and status	• Percent area of the establishment
2. Management of agricultural production areas	• Percent area of the establishment
3. Management of confined activities and animal husbandry	• Percent profit of the establishment, excluded non confined activities
4. Preservation of High Conservation Value Habitats	• Percent area of the establishment
5. Ecological corridors	• Preserve area (ha) and number of fragments
6. Landscape diversity *	• Shannon-Wiener index (calculated)
7. Productive diversity *	• Shannon-Wiener index (calculated)
8. Degraded areas reclamation *	• Percent area of the establishment
9. Incidence of vectors of endemic diseases	• Number of sources
10. Extinction risk of ecologically relevant species	• Number and status of (sub)populations
11. Fire risk	• Percent of the area of the establishment under risk
12. Geotechnical hazards	• Number of influenced areas
Environmental Quality	
Atmosphere	
13. Particulates / smoke	• Percent of time with occurrence
14. Odor	• Percent of time with occurrence
15. Noise	• Percent of time with occurrence
16. Carbon oxide / hydrocarbon emissions	• Percent of time with occurrence
17. Sulfur oxide emissions	• Percent of time with occurrence
18. Nitrogen oxide emissions	• Percent of time with occurrence
Water	
19. Dissolved oxygen *	• Percent O_2 saturation
20. Fecal coliforms *	• Number of colonies /100 ml
21. BOD_5 *	• Milligram/liter de O_2
22. pH *	• pH
23. Nitrate *	• Milligram NO_3/liter
24. Phosphate *	• Milligram P_2O_5/liter
25. Turbidity *	• Milligram suspended solids/liter
26. Chlorophyll a *	• Microgram chlorophyll/liter
27. Conductivity *	• Micro ohm/cm
28. Visual water pollution	• Percent of time with occurrence
29. Pesticides potential impact	• Percent of treated area
Groundwater	
30. Fecal coliforms *	• Number of colonies/100 ml
31. Nitrate *	• Milligram NO_3/liter
32. Conductivity *	• Micro ohm/cm
Soil quality	
33. Soil organic matter *	• Percent organic matter content
34. pH *	• pH
35. Phosphate *	• Milligram P/dm^3
36. Exchangeable K *	• Millimole of charge/dm^3
37. Exchangeable Mg (e Ca) *	• Millimole of charge/dm^3
38. Potential acidity (H + Al) *	• Millimole of charge/dm^3
39. Sum of bases *	• Millimole of charge/dm^3
40. Cation exchange capacity (CEC) *	• Millimole of charge/dm^3
41. Base saturation *	• Percent saturation
42. Erosion	• Percent of area of the establishment
Sociocultural values dimension	

43. Access to education *	• Number of people
44. Access to public services	• Access true or false (1 or 0)
45. Consumption standards	• Access true or false (1 or 0)
46. Access to sports and leisure	• Hours dedicated
47. Conservation of historic, artistic, archaeological, and speleological legacy	• Number of monuments/events/sites
48. Employment quality	• Percent of workers
49. Occupational safety and health	• Number of people exposed
50. Local opportunity for higher qualification employment	• Percent of workers
Economic values dimension	
51. Establishment net income	• Tendency of attributes (1 or 0)
52. Diversity of income sources	• Proportional share of profit sources
53. Income distribution	• Tendency of attributes (1 or 0)
54. Current indebtedness	• Tendency of attributes (1 or 0)
55. Land value	• Proportional share of value changes
56. Dwelling quality	• Proportional share of residents
Management and administration dimension	
57. Manager profile and dedication	• Occurrence of attributes (1 or 0)
58. Commercialization conditions	• Occurrence of attributes (1 or 0)
59. Wastes management	• Occurrence of attributes (1 or 0)
60. Management of chemical inputs and residues	• Occurrence of attributes (1 or 0)
61. Best management practices and efficiency	• Occurrence of attributes (1 or 0)
62. Monitoring and documentation	• Occurrence of attributes (1 or 0)
63. Local community relations	• Occurrence of attributes (1 or 0)
64. Institutional relationships	• Occurrence of attributes (1 or 0)

(*) Indicators expressed by two related measures, the impact index (a measure of indicator state) and the relative or proportional variation (a measure of indicator tendency), each converted into utility values.

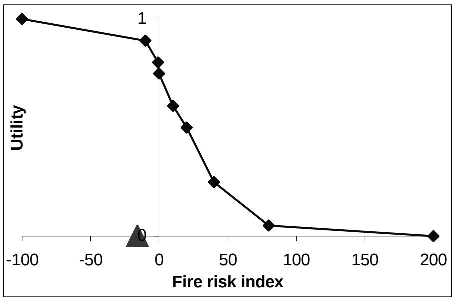
For each and every indicator, measurement variables refer to quantitative data measured in field surveys and based on administrative and historical knowledge of the farm manager, with no sophisticated or unordinary measurements being required for data gathering. In general, one working day suffices for completion of a field survey, with an analytic cost ranging from just around US$ 10.00 when field instrumentation can be made available, to about US$ 100.00 when all analytical parameters must be contracted with private laboratories.

Information obtained in the field surveys are fed directly into the system spreadsheets favoring participatory debate with the farmer during the assessments. These spreadsheets integrate all 64 indicators, each constructed in a specific scaling checklist, with weighting factors that translate field variables and environmental attributes into impact indices expressed graphically. Transformation functions are applied on these impact indices as to express environmental standards, legislation requirements and socio-economic benchmarks for each particular indicator in a normalized utility scale (from 0 to 1, with the baseline level modeled at 0.7; Figure 1).

Fire risk	Weighing factor for cause of risk k1	Sown pastures	Natural grasslands	Managed shub / savannah	Managed arboreal savannah	Eucalyptus forest	Pinus forest	Main crops	Natural habitat	Edifications / infrastructure	Check
Table of percent area under risk of fire											
Weighing factor for potential damage k2		0,05	0,1	0,1	0,25	0,5	0,5	0,75	0,9	1	
Tendency and cause of fire risk: Presence of PEAT SOILS	2										0
Increase due to intentional use of fire	1										0
Increase due to combustibles accumulation	0,5										0
Unchanged	0										0
Reduction due to combustibles elimination	-0,5	40	30						30		100
Reduction due to intentional fire elimination	-1										0
Fire risk index=	sum (percent area*k1*k2)										100

IFR = -16,00

IFR	Utility value
200	0
80	0,05
40	0,25
20	0,5
10	0,6
0	0,75
-1	0,8
-10	0,9
-100	1



Best fit equation for Utility

Sinusoidal fit: y=a+b*cos(cx+d)

Coefficients:
a = 0,58
b = 0,60
c = 0,02
d = 1,40

U-IFR= 0,86

Figure 2. Example of an indicator scaling checklist of the APOIA-OilPalm system. This typical scaling checklist integrates two attributes of fire risk, one for cause (k1, attribute of importance and direction of fire effect, according to its cause) and one for damage (k2, attribute on intensity of damage); associated weighting factors (for k1 and k2); equation for impact index calculation (Σ %area * k1 * k2); correspondence table of impact index (IFR) x environmental performance (utility values); IFR x utility value correspondence graph; and equation and coefficients for conversion to utility index (U-IFR). In the far right the 'value check' column ascertains the correctness of input data (value check=100%). The example expresses a field observation of fire risk reduction by elimination of grass leaf litter (in this case, by grazing rotation) in sown (40% area) and natural (30% area) pastures, which implies in decreased fire risk also in nearby natural habitats (30% area), resulting in IFR = -16 and U-IFR = 0.86.

Once all scaling checklists are filled in, impact indices are expressed in synthesis graphs for each of the sustainability dimensions, facilitating detection of critical control points for correction of negative impacts, as well as consideration of comparative advantages related with positive ones. Finally, impact indices are combined by mean utility values and integrated in a sustainability index for the rural establishment. After all field and laboratory data are entered into the spreadsheets and results are examined, an 'Environmental Management Report' is formulated and issued to the farmer, stressing recommendations of appropriate practices and technology adoption to minimize negative impacts and to promote positive ones, contributing toward the environmental management of the rural establishment.

Results

A) A preliminary case study on sustainable oil palm plantation management

The case study described in this section explains the application of the APOIA-OilPalm system onto oil palm production, as a preliminary step for the adaptation of the indicators to the specificities of the oil palm sector and the PC&I proposed by RSPO. The assessment was carried out at the Ishihara Farm, considering its 1978 oil palm plantation time frame (Rodrigues et al, 2007a).

The establishment was selected by indication of the Association of Palm Oil Producers Dentauá Ltd. and is located in the municipality of Santo Antônio do Tauá, in the Geographical Metropolitan Meso-region of Belém, State of Pará, Brazil. At 54m altitude and geographical coordinates 01^{o}06'13" S and 48^{o}07'34" W, in the ecological domain of the Amazon Equatorial Rain Forest, the 275 ha farm included oil palm plantation in approximately 192 ha, and a diversified agricultural productive base: black pepper (28 ha), açaí palm (28 ha), lemon (5 ha), papaya (5 ha), cupuaçu (2 ha), pineapple (2 ha), noni (5 ha), and woods (5 ha distributed among neem, teca, mahogany and gliricidium). Only 2.5 ha corresponded to native forests in the establishment, comprising a 'High Conservation Value Habitat' shoring a small stream.

B) Preliminary case study results

The APOIA-OilPalm system shows the assessment results in a synthesis graph for the sustainability dimensions, and an aggregate index for the establishment, according to the spatial and temporal context defined locally (Figure 2). For the case of Ishihara Farm this Sustainability Index reached 0.72, slightly above the conformity baseline defined in the method. Among the sustainability dimensions considered, quite favorable mean indicator results were obtained at Ishihara Farm for Water Quality (0.96) and Economic Values (0.79). Mean indicator values very close to the conformity baseline were obtained for Landscape Ecology (0.67), Socio-cultural Values (0.68) and Management & Administration (0.67). On the other hand, mean indicator results for the dimension Soil Quality (0.51) were below the conformity baseline defined in the APOIA-OilPalm system.

Environmental Performance		Number of lacking indicators
Landscape Ecology	0,67	0
Environmental Quality - Atmosphere	0,81	0
Environmental Quality - Waters	0,96	4
Environmental Quality - Soil	0,51	0
Sociocultural Values	0,68	0
Economic Values	0,79	0
Management & Administration	0,67	4

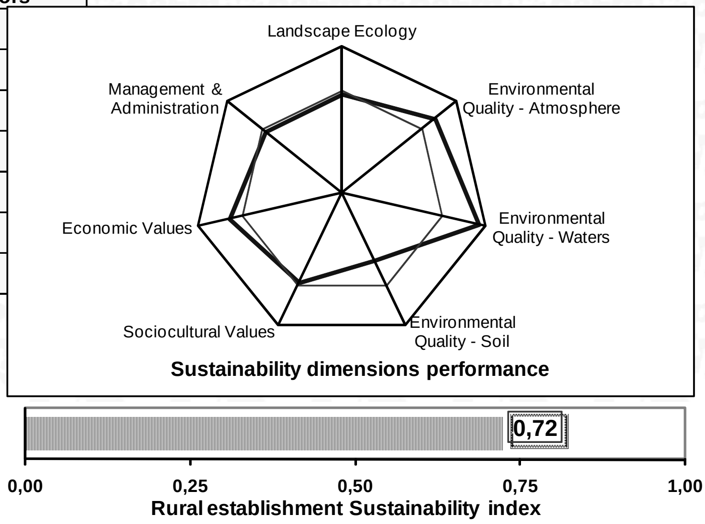


Figure 2. Sustainability assessment for Ishihara Oil Palm Farm, in Santo Antônio do Tauá (PA, Brazil), according to the APOIA-OilPalm sustainability assessment system.

The Landscape Ecology dimension (Figure 3) includes the indicator concerned with Natural habitats physiognomy and status (0.68), corresponding to only 3 ha, comprising a paludal forest in pristine condition, and a tract of recovering secondary rain forest, both very important for the High Conservation Value Habitats indicator (index = 0.82). The Management of agricultural production areas indicator (0.71) corresponded to approximately 262 ha at Ishihara Farm, fully taken by very diversified perennial crops and more importantly oil palm (70%), which was shown to be less intensive in terms of input use in the region, comparatively to the other crops. The Management of confined activities and animal husbandry indicator (0.64) corresponded to small-scale hog and poultry/eggs production for family consumption. When added to the large number of different crops grown at Ishihara Farm, the many productive activities resulted in a relatively high Productive diversity indicator (0.67, Shannon-Wiener index = 0.48), a positive factor for the farmer's economic security, against eventual market instabilities.

Even though below the baseline level defined in the assessment system, the Landscape diversity indicator was also satisfactory (0.59), owing to the perennial aspect of the crops, which contributed moderately for the conformation of Ecological corridors (0.68), and favored the protection of Ecologically relevant species (index = 0.80). The Incidence of vectors of endemic diseases indicator (index = 0.58) registered a problem brought about by the exotic African giant snail (*Achatina fulica*) that has caused damage to fruit trees and black pepper crops in the establishment. The oil palm plantation influenced negatively the Fire hazard indicator (0.50), due to the piling up of flammable organic material, both left from harvest operations and brought back from the industry and distributed under the trees. As in the eventuality of fire the main crop itself would be affected, causing severe losses, the effect on the sustainability index was deemed quite important. This practice, on the other hand, contributed with the organic matter balance in soils, as shown later on in the soil quality indicators.

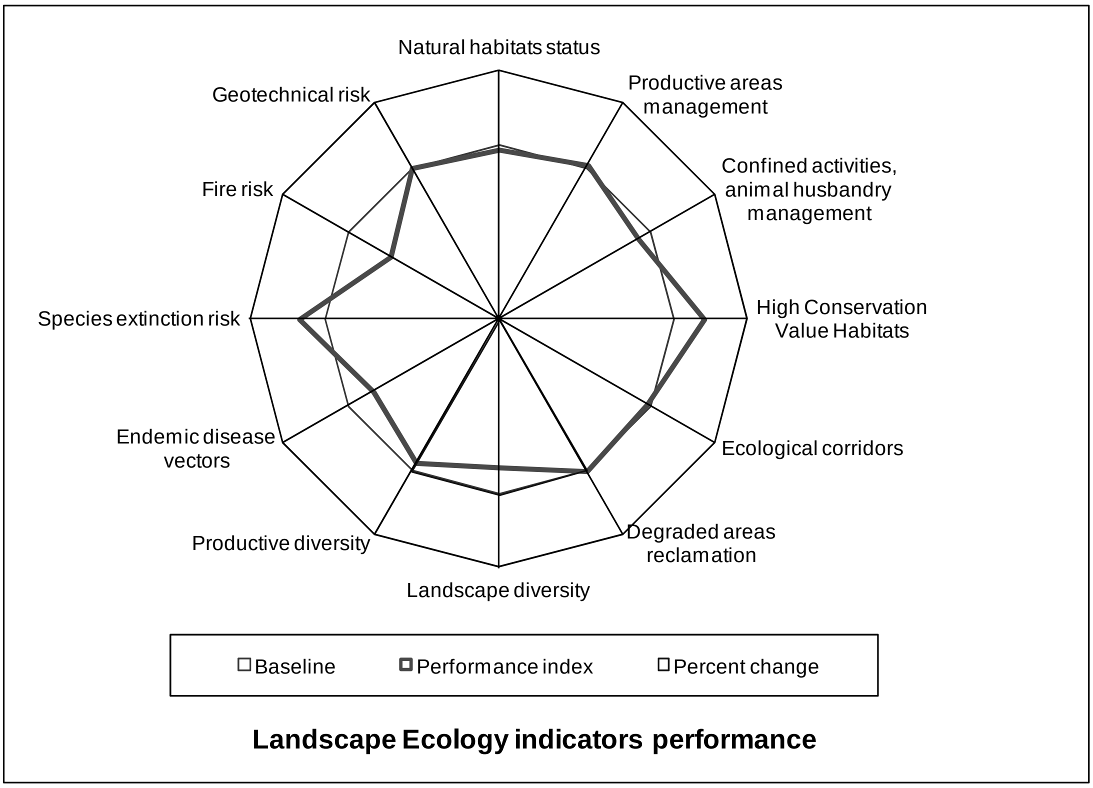


Figure 3. Sustainability indices for the Landscape Ecology indicators, Ishihara Oil Palm Farm, Santo Antônio do Tauá (PA, Brazil), according to the APOIA-OilPalm System.

The Environmental Quality dimension resulted well above the baseline conformity level for the indicators of Atmosphere (mean = 0.81) and Water Quality (0.96), whereas Soil Quality resulted well below that level (mean = 0.51). The Atmosphere indicators pointed out the absence of particulates and smoke emissions (for no burning is allowed in management, index = 0.89), absence of foul odors (1.0) and reduced period and low intensity of noise generation (0.92). Neither were there important sources of sulfur (0.70) or nitrogen oxides (0.70). On the other hand, the intermittent traffic of tractors for harvesting and management imposes some emission of carbon oxides (0.65) at the local scale.

The Water Quality showed positive indices for most indicators, pointing out the favorable influence of the perennial crops, especially oil palm, for water conservation. Surface waters analyzed showed adequate levels and excellent improvement in dissolved oxygen (index = 0.83, up 82%, with a tendency index = 0.97), adequate pH (index = 0.89), nitrate (1.0, under 2.0 mg/L), turbidity (index = 0.96), chlorophyll (1.0), conductivity (0.95), visual pollution (1.0), and potential pesticide impacts (1.0). Even though showing adequate conductivity (0.95), groundwater (sampled in the farm's well) showed increased levels of nitrate (up to 8.0 mg/L) but still well within good quality standards (index = 0.97).

The Soil Quality indicators represented the comparison between soils under oil palm and under orchards/plantation woods, areas that would be converted into oil palm when plantations would eventually be expanded in the establishment. The less intensive management and smaller input demand observed in the oil palm areas, which nearly excluded hydro-soluble fertilizers in favor of organic matter amendments, has brought strong decreases in soil fertility levels at Ishihara farm. Despite the slightly higher soil organic matter levels observed (index = 0.77), drastic decreases in phosphate (index = 0.09), potassium (index = 0.46), and magnesium (index = 0.55) were associated with high potential acidity (index = 0.50), resulting in very low sum of bases (index = 0.12), and bases saturation (index = 0.20). Important reduction in sheet erosion could be attributed to current oil palm plantation management practices (index = 0.75, Figure 4).

One can argue that this low mean index for the soil quality indicators does not represent a negative impact in the context of Ishihara farm. In effect, as palm oil plantation has been developed in the establishment without chemical inputs and with acceptable levels of economic gain (see below), this index points out actually a favorable aspect of oil palm cultivation in the area, rather than a negative impact of management. In other words, the assessment points out the viability of the activity practiced under lower levels of investment than needed for other crops, not a loss of soil productive capacity.

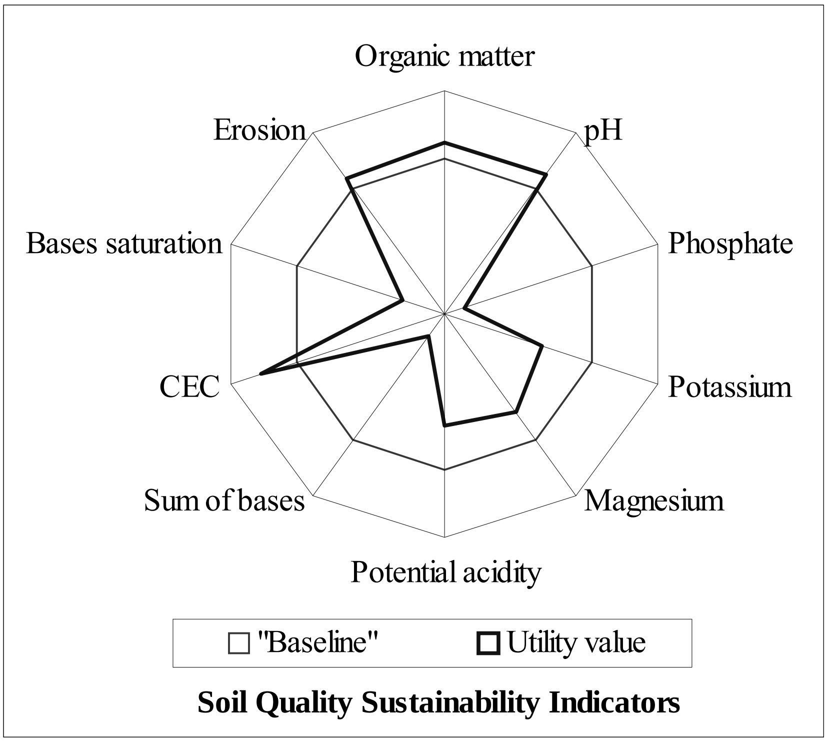


Figure 4. Sustainability indices for the Soil Quality indicators, Ishihara Oil Palm Farm, Santo Antônio do Tauá (PA, Brazil), according to the APOIA-OilPalm system.

The mean result for the indicators in the Sociocultural Values dimension at the Ishihara Farm (0.68, Figure 5) was very close to the baseline sustainability level of the APOIA-OilPalm system. The establishment housed the manager and eight family members, one temporary and 16 permanent workers. Regarding the Access to education indicator, only the manager received regular short training courses (offered by Dentauá Ltd.), with no other contribution accountable to the oil palm activity (index = 0.70).

The typically modest Consumption standards of the region, especially referring to the employees, resulted in a lower than the baseline index for this indicator (0.62), compared with relatively good conditions of Access to public services (index = 0.69). The activity showed no influential changes on the Access to sports and leisure (0.70) or the Conservation of cultural/historic legacy (0.70) indicators. The occupational safety and health indicator (index = 0.77) pointed out good working conditions, even though the Local opportunity for qualified employment (0.62) showed that only essentially manual, low specialization, field labor opportunities were made available by the productive activity. Most importantly, due to the virtual absence of fringe working benefits, and the uncertain contractual regime of the temporary worker, the quality of employment indicator was lower than the baseline sustainability level (index = 0.62).

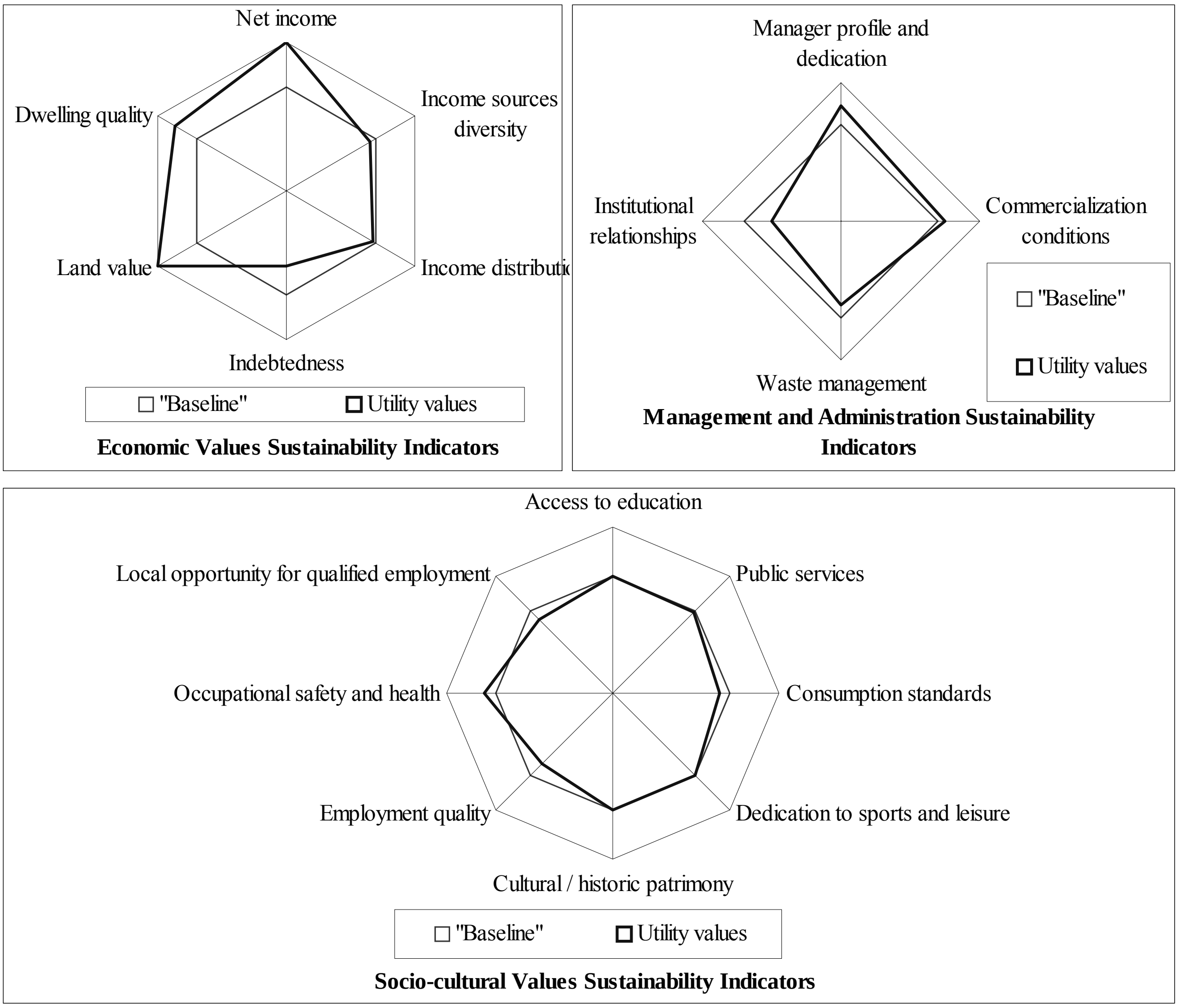


Figure 5. Sustainability index for the Socio-cultural Values, Economic Values and Management and Administration dimensions of the Ishihara Oil Palm Farm, Santo Antônio do Tauá (PA, Brazil), according to the APOIA-OilPalm system.

The Economic Values dimension (0.78, Figure 5) showed important indicators with indices well above the baseline sustainability level. Net income improved security, stability and amount (index = 1.0) resulted from the oil palm activity. Well diversified agricultural Income sources (0.70) were associated with a fair pattern of Income distribution (0.67, meaning 30-60% of net income distributed as wages). On the other hand, an increased Level of indebtedness (index = 0.50) resulted from loans obtained to renew plantations, and was associated with very important Land value improvements (1.0) resulting from those investments, and excellent Dwelling quality (0.86).

The Management & administration dimension (mean result = 0.67, Figure 5) showed very positive indicators, with important opportunities for improvement in the sustainability performance of Ishihara Farm, without need for heavy investments. Among the indicators denoting valuable management advantages brought about by the oil palm production activity, those related with the farmer Profile and dedication (0.83) stood out, including local residence, exclusive dedication, specialized training for the activity, family involvement, and formal accountancy system utilization. The Commercialization conditions indicator resulted above the baseline level of the APOIA-OilPalm system (index = 0.75), failing to comply only with some components less related with oil palm management, such as Linkage to services/activities and Association among local producers.

Even without regular public service for wastes removal, disposal of domestic residues was adequately performed at Ishihara farm, exception to sanitary sewage treatment. Solid domestic residues were selectively handled, with organic matter being incorporated to soils as amendment. Finally, the Institutional relationship indicator (index = 0.50) denoted availability of Formal technical assistance and Association/Cooperation, both offered by Dentauá Ltd., and also Access to legal consultation, while no Nominal technological affiliation or Continuous training could be referred to.

The sustainability assessment of the Ishihara oil palm farm pointed out important contributions of the main agricultural activity (oil palm plantation) for the socio-environmental performance of the establishment. The Sustainability Index obtained (0.72) stressed the conformity with the baseline proposed in the APOIA-OilPalm system, figuring as a target for continuous improvement and a tool for the farmer’s decision making regarding the adoption of technological innovations, managerial practices, and infra-structural and process investments for improving the establishment’s sustainability.

C) Preliminary case study discussion

The APOIA-OilPalm system has been shown to be a comprehensive environmental management tool, amenable to expedite field application by trained technicians, and adequate for distribution and use at low cost, generating objective reports in printed format of easy interpretation. The system facilitated the detection of critical impacts for management practices and technology corrections, as well as the quantification of favorable impacts, which may contribute toward sustainable resources exploitation and natural habitats conservation.

The set of indicators combine, at the rural establishment scale, issues related with ecological integrity, economic vitality and socio-cultural equity measures for local sustainable development, all explicit objectives of the palm oil productive sector, expressed in the “Roundtable for Sustainable Palm Oil” Certification Systems (RSPO, 2007), which include smallholders and medium size operations (RSPO, 2006), such as the one involved in the present exercise.

Even though not immediately addressing certification objectives, the sustainability assessment procedure detailed in the present case study can be considered a contribution toward the organization of a farm's environmental management practices, and of the associated information and documentation, in a straightforward, systemic and reproducible fashion. Additionally, the procedures carried out in this case study favored the gathering of experience in order to promote the needed adaptations, aiming at the objective verification of the efficacy of certification processes to effect environmental quality improvements in the Oil Palm Sector.

D) Validation field trials – APOIA-OilPalm evaluations in Indonesia

The case study detailed in this section is related with an applicability test of the APOIA-OilPalm methodology, carried out in a PT-SMARTRI / Cirad / Embrapa series of field assays. Results report on 13 field assessments, related with the main PT-SMART plantation, the Plasma Estate and 11 associated smallholders in Riau, Indonesia. The assessments were initiated as field activities in the PT-SMARTRI Training Workshop on the APOIA-OilPalm system (24-28/11/2009) and continued as complementary training activities carried out by the PT-SMARTRI technicians and engineers, participants of the Workshop, then in the November 2008 - May 2009 period.

E) Indonesia field trial results

A clear contrast was observed for the set of sustainability evaluations, with the two large scale establishments reaching better results (the PT-SMART Plantation and the Plasma ensemble, with sustainability indices = 0.76 and 0.70, respectively) and none of the smallholders attaining the baseline level (Figure 6). Corroborating this general trend, very high correlation coefficients were observed for the set of performance indices (for each of the dimensions) and the sustainability indices among smallholders (smallest value = 0.82), with 77% of correlation coefficients above 0.90. These results indicate a high level of homogeneity among all smallholders, and a clear contrast with the large scale establishments, when the whole dataset is regarded.

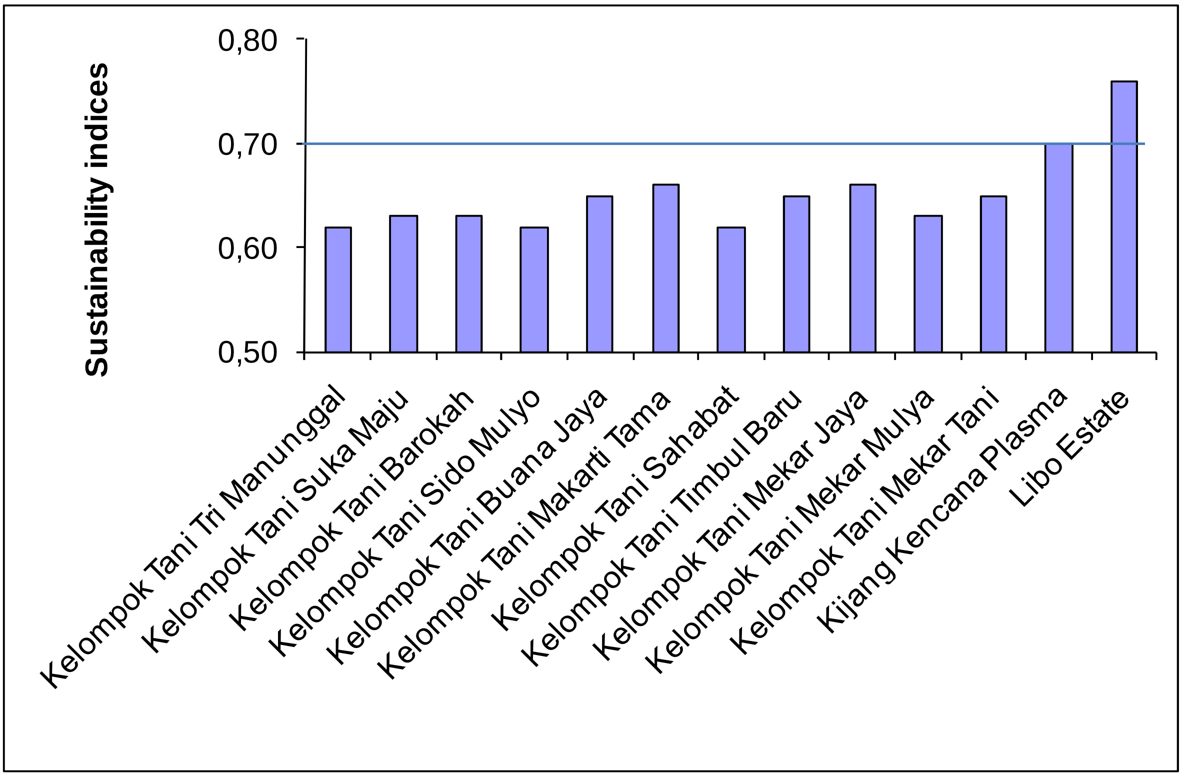


Figure 6. Sustainability indices obtained in the assessments carried out in 11 smalholder plots and two large scale establishments (Kijang Kengana Plasma ensemble and Libo Estate). Results obtained with application of the APOIA-OilPalm system, as a methodology validation step in the Training Workshop program held in Riau, Indonesia.

A clear hierarchy was observed for the distribution of results relative to the sustainability dimensions, with the Management and administration showing the lowest mean indices (exception to the two large scale plantations), Landscape ecology being the second lowest, followed by Environmental quality still with mean below the baseline level; then Sociocultural values and Economic values attaining the best mean result (Figure 7).

When all assessments carried out are viewed together, irrespective of production scale, higher correlation coefficients between the environmental impact indices (for each dimension) and the integrated Sustainability indices were obtained for the Management and administration (0.88) and the Environmental quality (0.72) dimensions (Figure 7). Most of this correlation between the Sustainability index and the Environmental quality indices were explained by the Soil quality data (corr. coef. 0.80), while Water quality showed low correlation levels (0.26) and Atmosphere showed negative correlation (-0.84). This implies that those establishments shown to perform better (Plasma and Libo) were those where soil fertility levels were better managed. On the other hand, the high correlation levels between the sustainability indices and the Management and administration performances mean that such are the priority indicators to be improved in order to ameliorate the sustainability of smallholders.

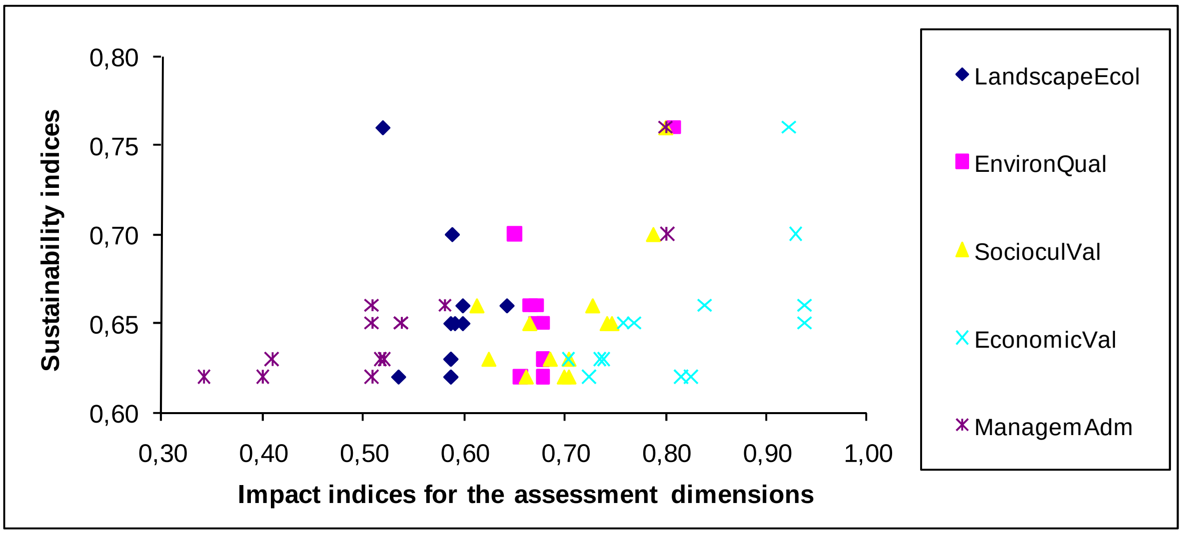


Figure 7. Results of assessments carried out with the APOIA-OilPalm system in the Training Workshop program held in Indonesia (n= 13), showing the distribution of impact indices for the assessment dimensions and the associated Sustainability indices.

Reasonably high levels of correlation were also observed between the sustainability indices and the Sociocultural values (0.65) as well as the Economic values (0.64) indices, indicating that implementation of oil palm plantations favorably influenced quality of life and livelihoods in the studied set of establishments. Conversely, a negative correlation (-0.36) was observed between sustainability levels and the Landscape ecology dimension, implying that sustainability has been attained at the expense of nature preservation.

This statement may come as no surprise; however, the assessments allow clear indication of main constraints to sustainability, or in other words, priorities for management correction. Among these, the most important to be stressed are those related with recovery of natural vegetation in areas classified as High Conservation Value Habitats, which would simultaneously favor improvement in Ecological corridors, ameliorate landscape diversity, and favor conservation of populations of ecologically relevant species.

F) Discussion on the validation field trials in Indonesia

The APOIA-OilPalm spreadsheets have been shown to be self-explicative, easily distributed and inexpensive for data collection, allowing report emission in printed format of simple understanding, both under plantation and smallholder contexts. The application of the system is directed at promoting the environmental management of the oil palm plantation, pointing out critical points for management correction, as well as adequate practices and natural resources use aspects for fostering sustainable, environmentally sound and socially responsible production.

Although some of the indicators were left unanalyzed in the studies presented in this section, the independent and satisfactory completion of assessments carried out by the group of participants of the PT-SMARTRI Training Workshop can be deemed as an indication of the practicality of the proposed methodology. Also, the involvement of smallholders as well as large scale establishments, with general data analysis carried out altogether, imply good malleability both for the set of indicators and for the composite sustainability index. The verification of correspondence between RSPO proposed Principles and Criteria and the indicators comprised in the APOIA-OilPalm method attest to the applicability of the procedure as a preparation step in the palm oil certification process.

Discussion and conclusions

A wealth of methodological approaches is being made available to fulfill an international demand for sustainability indicators and impact assessment systems (Riley, 2001) in a concerted challenge to promote sustainable rural livelihoods and to foment certification initiatives (Cramer, 2007). The APOIA-OilPalm is one additional approach, proposed as a comprehensive method, sufficient for field sustainability assessments at the rural establishment level and to promote preparation of producers toward certification procedures.

The system comprises ecological, sociocultural, and economic (including management and administration) dimensions, integrated into an objective measure of rural activities' contributions to local sustainable development. The method is straightforwardly applicable by trained researchers and technicians, allows the active participation of farmers / managers, and facilitates the storage and communication of information concerning environmental impacts. The computational platform is readily available and allows issuance of easy-to-interpret printable graphic outputs. A template is available for the formulation of Environmental Management Reports, facilitating recommendation of practices and technologies for correction of faulty indicators and promotion of positive ones. Finally, the correspondence built in the system with the Principles and Criteria for RSPO certification favors its utilization by farmers to document certification processes.

A differential brought by the method is the design symmetry of indicators, the explicit expression of their operations and variable transformation procedures, and the easily identifiable quantitative relationships between field variables, calculated impact values, and the composite sustainability index. These methodological characteristics represent an evolution departing from the ‘environmental impact units’ concept proposed by Dee et al. (1973), with a modular solution for calculating ‘functional curves’ (Canter and Hill, 1979; Orea, 1998) for the multiattribute-utility value impact index expressed in the scaling checklist (Bisset, 1987) for each indicator, as well as for the composite sustainability index (Singh et al., 2009).

The results obtained in the sustainability assessments according to particular environmental indicators offer a diagnostic tool for farmers / managers, pointing out how agricultural practices may comply with defined environmental standards and socioeconomic benchmarks. Additionally, the indicators show a measurement of the relative variation and temporal tendency of impacts imposed by agricultural practices, indicating corrective courses of action for management.

The results combined according to the integrated dimensions (ecological, economic, sociocultural) provide decision-makers with an overview of the effects, both positive and negative, of rural activities on local sustainable development, facilitating the selection and recommendation of incentive policies or control measures at the local community level. Finally, the ‘sustainability index’ can function as a yardstick for certification, as well as a measure of the contributions of rural activities to local development, meeting the demands of farmers, administrators, decision-makers and rural organizations, pursuant to defined objectives of combining ecological integrity, economic vitality and sociocultural equity measures for local sustainable development.

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